FED COMMUNICATION ON FINANCIAL STABILITY CONCERNS AND MONETARY POLICY DECISIONS: REVELATIONS FROM SPEECHES

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Abstract

This paper studies the informational content of speeches of Fed officials, focusing on financial stability, from 1997 to 2018. We construct indicators that measure the intensity and tone of this topic for both Governors and Fed presidents. When added to a standard forward-looking Taylor rule, a higher topic intensity or negative tone is associated with more monetary policy accommodation than implied by the state of the economy. Our results are mainly driven by the information in speeches of Fed presidents. We discuss several channels to rationalize this finding.

Keywords: monetary policy, Federal Reserve, financial stability, communication.

JEL classification: E03, E50, E61.

Resumen

Este trabajo estudia el contenido de los discursos de los funcionarios de la Fed, poniendo el foco en la estabilidad financiera, desde 1997 hasta 2018. En él se desarrollan indicadores que miden tanto la intensidad como el tono de los discursos de los miembros de la Junta de Gobernadores y los distintos presidentes de la Fed regionales al hablar de este tema. Cuando estos indicadores se introducen en una regla de Taylor *forward-looking,* encontramos que una mayor intensidad del tema o un tono negativo del discurso se asocian con una política monetaria más acomodaticia que la que se derivaría del estado de la economía. Nuestros resultados de la regla de Taylor se basan principalmente en la información de los discursos de los presidentes de la Fed. Analizamos varios canales, que refrendan este resultado.

Palabras clave: política monetaria, Reserva Federal, estabilidad financiera, comunicación.

Códigos JEL: E03, E50, E61.

1 Introduction

This paper studies the informational content of speeches of Fed officials with respect to financial stability concerns. Although the Federal Reserve does not have an explicit financial stability objective that extends beyond its supervisory responsibilities, the narrow interpretation of the dual mandate, i.e. ignoring any financial stability risks beyond their direct effect on inflation and employment "does not seem credible" (Kashyap and Siegert, 2020). In 2018, the Federal Reserve Board launched a biannual Financial Stability Report (FSR), which explicitly monitors the resilience of the US financial system. While rich in analysis, the FSR does not provide a discussion of the policy implications of financial stability for the Fed or other authorities (Kashyap and Siegert, 2020). The lack of a formal communication strategy on these implications is also recognized within the Federal Open Market Committee (FOMC):

> *Some participants remarked that, because financial stability risks are a consideration for achieving the Committee's dual mandate, a clear communications strategy would be needed to convey the Committee's assessments of financial vulnerabilities and their potential implications for the monetary policy outlook.*
>
> — FOMC minutes, January 2020

However, even in the absence of an institutionalized communication strategy, FOMC members[1] might still express their view on financial stability risks and policy consequences through public remarks.

Therefore, the goal of this paper is to assess what Fed officials' speeches (1997-2018) reveal about their financial stability concerns and whether these concerns systematically relate to monetary policy decisions. In other words, our analysis aims to analyze past Fed decisions, associating policy actions with the importance Fed officials place on financial stability issues in their speeches. The advantage of analyzing speeches is that they give the speaker discretion over the content, and, to some extent, reflect debates and opinions that have also been expressed in FOMC meetings and, therefore, have guided policy (Bernanke, 2015).

Our results show that when Fed officials communicate more about financial stability, the Federal Reserve provides accommodation beyond what the state of the economy suggests. We further assess whether the institutional role of the speaker matters and find that speeches of Federal Reserve Bank (FRB) presidents contain a stronger signal for this relationship than speeches of Fed Chairs and those of other members of the Board of Governors (Governors).

To investigate the role of financial stability concerns for monetary policy, we consider the big picture of how financial stability considerations are communicated and dealt with by looking at three typical dimensions of a central bank policy strategy: the objective, the analysis of economic developments and the policy response.[2] The "objective" dimension, which we label Financial Stability (FS), relates to communication about excessive risk-taking behavior or vulnerabilities in financial markets. Note that, differently from price stability, financial stability is not easily quantifiable with one variable (nor a simple or weighted average of many of them). The "analysis"

[1] Note that throughout the paper, "FOMC" refers to all Board members and all Federal Reserve Bank presidents (not only those with voting rights).

[2] A parallel can be made in this respect with the objective of price stability, and the related economic analysis and monetary policy decision.

dimension, which we label Financial Conditions (FC), refers to communication about financial and banking developments that are also part of the monetary policy strategy to monitor the economy and assess risks to the fulfillment of the dual mandate. The assessment of these conditions is also part of a typical FSR. In the analysis dimension, we also include the monitoring of the housing market, which can generally be considered as being part of financial conditions but, given its prominence in the U.S. economy, we consider as a separate topic. Finally, the "policy dimension", which we refer to as Supervision and Regulation (S&R), relates to the supervisory and regulatory efforts taken by the Fed, alone or in cooperation with other agencies, to mitigate the risks and consequences of financial instabilities. We refer to these four topics as the financial-related topics.

We use textual analysis techniques (refined with expert knowledge) to quantify Fed communication and compute two speech-based indicators. First, we classify each speech into different economic and financial-related topics and calculate what we label *topic proportions*: the share of a speech dedicated to a specific topic. Second, we further calculate a *tone indicator* based on a dictionary of words that relates to central bank language expressed in financial stability reports, taken from Correa et al. (2021).

Looking at the period 1997 to 2018, we observe that FRB presidents gave more speeches than Governors around and after the global financial crisis. Moreover, FRB presidents exhibit more variation in the topic proportions of their speeches and dedicate a larger share of them to the economic outlook and monetary policy compared to Governors. Only during the financial crisis, we observe that speeches of FRB presidents got more balanced in terms of topic shares, with the financial-related topics gaining importance. In the aftermath of the financial crisis, FRB presidents move back to a more intense communication on monetary policy, reflecting their concerns about unconventional tools, exit strategies, and a desire for normalization. These differences likely reflect the institutional design and different responsibilities of FRB presidents versus Governors.

To assess the relevance of financial stability communication for monetary policy decisions, we include our speech-based indicators in a standard forward-looking Taylor rule. Our results for the period 1997 to 2013 show that these indicators are relevant explanatory variables for policy rate changes, providing additional information to what is captured by the Fed's internal forecasts of output gap and inflation. A higher speaking time (topic proportion) or a higher negative tone on Financial Conditions, Financial Stability and Supervision and Regulation correlate with a more accommodative monetary policy stance while communication on Housing with a tighter policy stance. These effects are also economically significant in terms of their magnitude; for estimates prior to the the global financial crisis (until 2007), a one percentage point increase in the Financial Stability topic proportion is associated with a decrease in the Federal Funds Rate by around 5 basis points on impact. Importantly, results are robust to the inclusion of standard financial indicators based on market data, such as the VIX, implying that our speech-based measure provides additional information.

By incorporating information that reflects the importance Fed officials place on financial stability issues, we show that financial stability concerns help to explain the Fed's monetary policy stance. Our results suggest that the Fed has acted rather to "clean" or "mitigate" the damages than to "lean" against financial imbalances. Interestingly, we uncover a "leaning" stance when considering housing market concerns.

Finally, we find that the speeches of Fed presidents convey a stronger signal on the likely direction of monetary policy than those of Governors. This result is neither driven by the NY

Fed president nor by the voter versus non-voter status of Fed presidents. While there might be other factors that matter, we argue that since Fed presidents have less specialized positions than Governors, are more numerous and flexible in choosing the topics of their speeches, they provide a stronger signal when talking.

Our study relates to several strands of the literature. First, it contributes to understanding the role and informational content of central bank communication (see Blinder et al. (2008) for an extensive survey).[3] We show that speeches given by FOMC members carry information that is systemically related to Fed policy decisions. Further, our paper highlights differences in communication patterns between Governors and FRB presidents, the institutional design, and the multidimensional aspects of communication. By looking at the role of the speaker, we also relate to the literature of decision-making in committees (Blinder, 2007; Riboni and Ruge-Murcia, 2010; Swank et al., 2008).

Moreover, our paper contributes to the literature that studies the role of financial (in)stability concerns for monetary policy. A strand of this literature has augmented Taylor rules with a particular asset price or financial indicators (Bernanke and Gertler, 1999, 2001; Cecchetti et al., 2000; Fuhrer and Tootell, 2008). In this paper, we show that our speech-based measures provide information beyond standard financial indicators.

Another strand of the literature has used text-based measures to investigate the relationship between financial stability and monetary policy (Friedrich et al., 2019; Wischnewsky et al., 2019; Peek et al., 2016). Whereas we analyse speeches, these papers have looked at other forms of communication. For instance, Friedrich et al. (2019) look at mandates, regulations and monetary policy statements of several central banks to construct a financial stability orientation index. Peek et al. (2016) look at FOMC meeting transcripts to capture the intensity of financial instability concerns and Wischnewsky et al. (2019) look at the semiannual Congressional hearings of Fed chairs to build a tone measure of financial stability. We contribute with several speech indicators (topic proportion and tone) concerning different dimensions of financial stability (i.e., Financial Conditions, Financial Stability and Supervision and Regulation) and show a robust negative relationship between financial stability concerns and the Fed's policy rate. The latter result is in line with findings in the previous literature. We provide additional results for the Housing topic and find a positive relationship between the topic's intensity and the policy rate.

More generally, we also relate to the literature on textual analysis applied to the U.S. monetary policy. For instance, Hansen and McMahon (2016); Hubert and Labondance (2021) have looked at FOMC policy statements and minutes while Ehrmann et al. (2019) and Malmendier et al. (2021) at Fed speeches; Van Dieijen and Lumsdaine (2019) look at speeches of Board members but do not consider financial stability implications for monetary policy.

The paper is organized as follows. Section 2 describes our dataset and the methodology used to construct our topic proportion and tone measures and provides insights into their evolution over time and compare them to standard financial indicators. In Section 3, we show the main results based on forward-looking Taylor rule regressions, discuss some potential channels behind our findings and show robustness results. Section 4 concludes.

[3] Born et al. (2014) have assessed the effect of financial stability communication of central banks on financial markets, focussing on FSRs and speeches of the heads of several central banks.

2 Speech communication measures and their dynamics over time

2.1 Fed Speeches

There are several reasons why speeches given by members of the FOMC could contain useful information. Firstly, compared to other forms of Fed communication, speeches provide real-time publicly accessible information on a variety of topics. In contrast to FOMC policy statements and biannual testimonies of the Federal Reserve Chair to the Congress, Fed speeches allow for more discretion on the side of the speaker and cover a broader range of topics with time-varying intensity. Second, due to the degrees of freedom in their format and the greater variety of speakers, speeches reflect to a larger extent the diversity of opinions expressed within the Fed, both in the cross-section of Fed officials and over time. In Bernanke's (2015) words, each FOMC participant gets only a few minutes to express their policy views during the meeting and one can think of speeches as a continuation of the FOMC debate in other venues.[4] Moreover, often, speeches are used to initiate debates, to strategically communicate the speaker's opinion, or to influence both markets and their colleagues' expectations before FOMC meetings (Ehrmann et al., 2019). Therefore, speeches could reveal information about considerations not reported in other standard forms of Fed communication that might have influenced policy nonetheless.

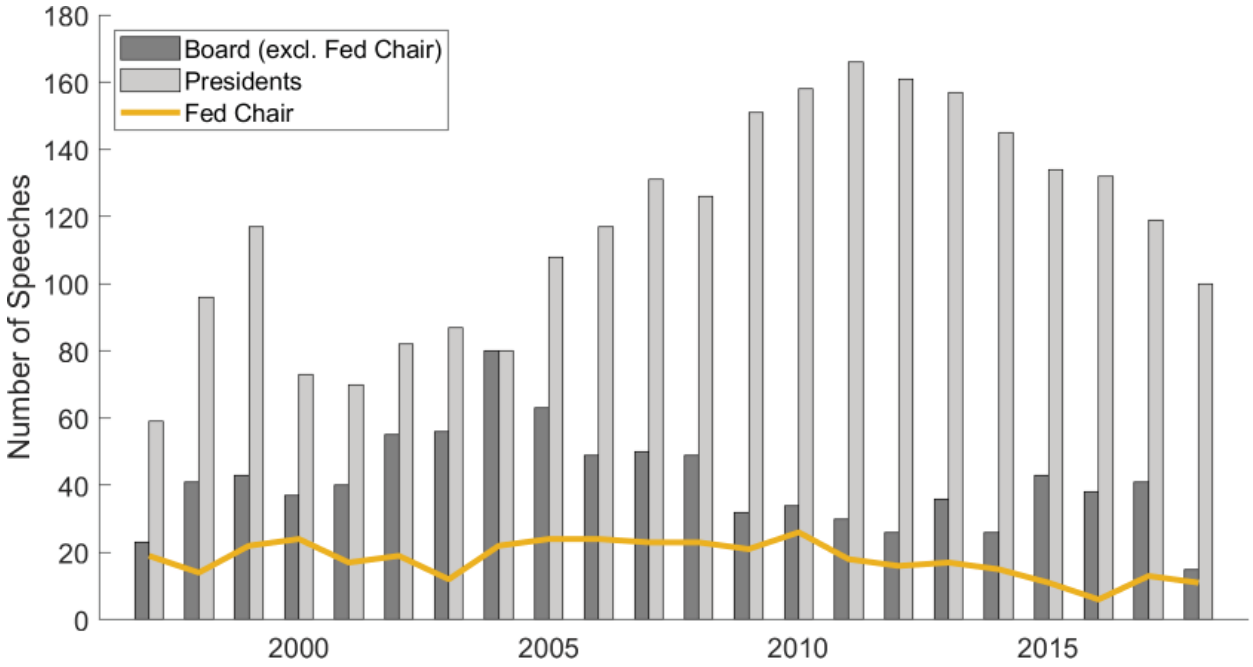
Our data set consists of publicly accessible speeches given by the Chair of the Federal Reserve (Fed Chair), the other members of the Board of Governors (Governors) and the presidents of the 12 Federal Reserve Banks (FRB presidents). These speeches are available from the website of the Federal Reserve Board and the respective websites of the Federal Reserve Banks. For each speech, we observe and record the text of the speech, its title, the speaker, and the date the speech was given. Our data sample ranges from January 1997 to December 2018 and consists of a total of 3851 speeches. For the rest of the paper, we will refer to the set of all speeches as the corpus.

Figure 1 shows the number of speeches over time, grouped into the speeches of four Fed Chairs (Alan Greenspan, Ben S. Bernanke, Janet L. Yellen, and Jerome H. Powell), 23 Governors and 35 different FRB presidents, who served from 1997 to 2018. We observe that Fed Chairs have given a rather constant number of speeches over time. The same holds for Governors, although the number of speeches per year varies more than for the Fed Chair and declined during the Zero Lower Bound (ZLB) period. Part of this decline could be due to many unfilled Board seats since 2010 — out of a seven-member Board, the number of Board members has been as low as three (including the Fed Chair). Another reason could be a more cautious communication policy as the contemporaneous decline in Fed Chair speeches also suggest.

FRB presidents, in turn, have been increasingly vocal during the financial crisis and the ZLB period, and to a lesser extent during the Asian and Russian crisis in 1997/1999. Roughly with the onset of policy normalization, the number of speeches of Fed presidents started to fall and reached pre-crisis levels in 2018. A part of the variation in the number of speeches over time could also relate to speaker fixed effects, i.e. to the personality of certain FOMC members. For instance, some FRB presidents communicated more than their peers through speeches, having an impact on the total number of speeches.

[4] This is in line with the large amount of attention that Fed watchers pay towards speeches.

Figure 1: Fed speeches by type of speaker, 1997 to 2018



Note: The figure shows the total of number of speeches per year. Speeches of Dallas Fed Presidents start only in January 2004. Source: Website of the Federal Reserve Board, respective websites of the Federal Reserve Banks and authors' calculations.

2.2 Topic Modeling

To convert the raw text from Fed speeches into meaningful quantities that we can analyze, we combine computational linguistic tools with our expert knowledge, and classify each speech into different topics. The computational tools allow us to get preliminary dictionaries based on the information in the 3,851 speeches; in a second step, we refine these preliminary dictionaries to better capture nuances. In short, these steps consist of:

1. Preprocessing the corpus.
2. Obtaining "economics-themed" topics from clusters of a latent dirichlet allocation (LDA).
3. Refining "economics-themed" topics by adding words from *unmatched* LDA words.

In the first step we transform all words to lower letter words, remove punctuations and numbers, remove stop words, such as "the", "and" and "a" and create word collocations (of up to three words); for instance, the term "annual stress test" is represented as "annual", "stress", "test" and "annual.stress.test". Next, we prune, i.e. we retain words that occur in at least 10 speeches, and word collocations that occur in at least five speeches.

In the second step, we estimate a topic model based on a latent Dirichlet allocation (Blei et al., 2003), which is an unsupervised learning algorithm that clusters terms according to their co-occurrence across speeches. The input required by the LDA algorithm is a corpus and a pre-specified number of clusters C. The output is a list of words for each cluster and a series of proportions that express the share of speech d that is captured by terms in topic k, denoted by $\{\theta_k\}_{d=1}^{D} \in [0,1]$, for $c = 1, ..., C$, where D denotes the total number of speeches and c is the cluster

index. In our estimation, the LDA uses $C = 40$. Since LDA models have become popular in economic research, we do not discuss the methodology in further detail here. Prior specifications for the document-topic and topic-word distributions are taken from Hansen and McMahon (2016).

Then, using the 20 most relevant[5] words of each cluster, we allocate the 40 clusters into 12 "economics-themed" topics: Economy, Monetary Policy, Financial Stability, Supervision and Regulation, Financial Conditions, Housing, International, Fiscal, Financial Risk Management, Community, Research, Payments. Six of the 40 clusters have topic-word distributions that do not relate to economic themes in a systematic way, and we discard these clusters from our analysis. Terms that are not in the preliminary dictionaries of the 12 topics are what we label *unmatched* words.

We decided to estimate the LDA with 40 clusters, and not, for example, directly 12, because our aim is to construct topics that are associated with a specific economic theme rather than being based on simple co-occurence. For instance, the economic outlook and monetary policy decisions might often be discussed together, but we want to treat them as distinct topics.

Table 1 shows an example of five of the 40 clusters estimated by the LDA. The column titles are the economic topic that we assigned to the cluster, and the words are the 10 most relevant words of the respective cluster.[6]

Table 1: Raw LDA results - examples

Economy	Monetary Policy	Financial Stability	Supervision & Regulation	Housing
productivity	monetary_policy	financial	regulators	mortgage
growth	central_bank	system	market_discipline	borrowers
productivity_growth	policy	financial_stability	standards	lenders
investment	reserves	capital	capital_requirements	credit
labor	balance_sheet	leverage	regulation	loans
expansion	actions	crisis	supervision	housing
rate	federal_reserve	financial_institutions	supervisory	loan
output	Fed	stress	rules	mortgages
tech	independence	risks	regulatory	cra
technology	policies	institutions	disclosures	foreclosures

Note: The table shows the first 10 words of five examples of the 40 clusters estimated via the LDA. The column label was assigned by the authors.

In the third and final step, we refine the preliminary dictionaries by adding *unmatched* terms, i.e. words that are in the corpus but are not assigned to the first 20 words of the selected clusters. A word can be unmatched mainly because it cannot be associated with any of the economic topics, the LDA misclassified it or it appears infrequently. Consequently, most of the unmatched terms are either adjectives, words not specific to economics or very specialized terms. To avoid a loss of information due to the latter reason, we selected terms from this list and assigned them to our 12 topics based on our expert knowledge. For instance, among the unmatched terms, we assigned the term "accommodative_monetary_policy" to the Monetary Policy topic and the term

[5]The relevance of a term is determined by a weighted average of the topic-word probability and the relative frequency of the word in the corpus; we use a weight of 0.6 for the former, as suggested by Sievert and Shirley (2014).

[6]The LDA can assign similar words to different topics, as similar words can be used in different context. For this reason and we did not opt for a mutually exclusive allocation of LDA terms.

"macroprudential_supervision" to the Supervision and Regulation topic. The total number of unmatched terms is 16,468 of which we assign by hand 1959 terms to one of our 12 topics.[7]

Figure 2 displays several *word clouds* with the 50 terms that occur most frequently in Fed speeches for our six main topics of interest (Economy, Monetary Policy and of the four financial-related topics). The font size of a term is proportional to its relative frequency to all other terms in the respective topic. For instance, Panel (a) shows the words for the topic Economy and its most frequent words "economy" and "growth". For the Monetary Policy topic in Panel (b), "inflation" and "monetary_policy" are among the top words used, i.e. words that relate to the goals and tools of monetary policy, and terms that relate to the dual mandate of the Federal Reserve such as "price stability", "goals", and "long run".

Figure 2: Word clouds of selected topics

(a) Economy (b) Monetary Policy (c) Housing

(d) Financial Conditions (e) Financial Stability (f) Supervision and Regulation

Note: The figures show the 50 most frequent words for the main six topics of interest. The font size is proportional to the frequency of the word relative to the frequency of other words in the same topic.

Panels (c) to (f) of Figure 2 display the word clouds for the financial-related topics: Housing, Financial Conditions, Financial Stability, and Supervision and Regulation. The Financial Conditions topic broadly covers the communication about lending and borrowings conditions in the economy (i.e. words about households and firms) or about banking conditions. The analysis of these conditions, together with the Economy topic, is part of the monetary policy strategy to monitor the economic developments and assess risks to the fulfillment of the dual mandate. The

[7] In Section 3.4 we show that our empirical Taylor rule results are robust to leaving out step three with unmatched words as well as to stemming the corpus in the preprocessing step.

FOMC policy statement often reads that the Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output. The analysis of financial and banking conditions constitutes also the main part of a typical Financial Stability Report (FSR), therefore we consider it an important element to asses financial stability communication. We also consider the Housing topic as part of the financial conditions but treat it separately in order to asses the importance of this topic for the Federal Reserve. The Housing topic is comprised of words that define lending and borrowing conditions in the housing market.

The Financial Stability (FS) topic, at the center of our analysis, relates to communication about excessive behavior in financial markets, "losses", "volatility", "systemic" and "leverage", i.e. vulnerabilities in the financial system that are likely to have large effects on the economy. This discussion is also typically found in a FSR. Finally, the policy layer, Supervision and Regulation relates to the supervisory and regulatory efforts taken by the Fed, alone or in cooperation with other agencies, to mitigate financial risks and prevent financial instability ("basel_ii", "regulation", "stress_tests", among others).

Figure 2 shows that the three topics in panels (d) to (f) share common words like financial, bank, risk, and capital, among others. However, these topics have also specialized words that reflect their differences as described above. Financial Conditions shares 20 words with the FS topic (around 7% of its total words), while Supervision and Regulation shares 24 words with FS (around 6%), and the rest of the topics not more than 4 words.

As for the other topics, Risk Management and Payments cover risk management and accounting practices, and the technical side of the US digital payment infrastructure, respectively. Community is associated with FRB presidents addressing the community developments of their respective jurisdictions. Research includes mainly references to academic economic research. As we will see below, together with International and Fiscal, these latter six topics have a combined average share in speeches of about 30%, whereas the former six make up an average 70% of the speaking time.

2.3 Topic Proportion

In the following we look at the evolution of the importance of our topics over time. For a given speech d and a topic $k = 1, ..., 12$, the proportion of each topic is computed as follows :

$$\text{Topic Proportion}_{k,d} = \text{TP}_{k,d} = \frac{\sum_{j=1}^{R_k} r_{k,d,j}}{\sum_{i=1}^{12} \sum_{j=1}^{R_i} r_{i,d,j}}, \tag{1}$$

where R_k denotes the total number of terms in the topic k, $r_{k,d,j}$ denotes the number of occurrences of topic k's term j in speech d. The numerator counts the number of occurrences of topic k terms, and the denominator divides by the number of occurrences of terms of all topics, i.e. the measure adjusts for double-counting of terms that appear in more than one topic, and sums to one.

To get a topic proportion index at a FOMC meeting frequency, we aggregate the topic proportion of all speeches given between meetings by taking the average:

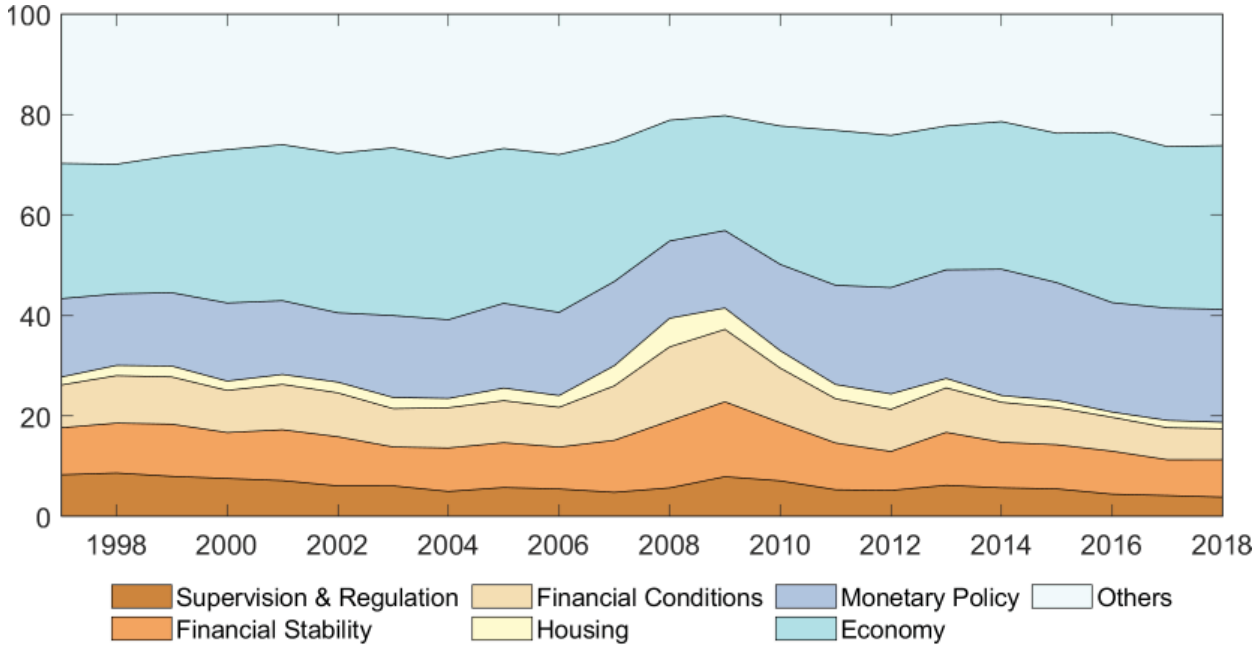
$$\text{TP}_t = \frac{1}{M_t} \sum_{d \in m_t} \text{TP}_{k,d}, \tag{2}$$

where t is at meeting frequency, m_t denotes the set of speeches given between meeting $t-1$ and t, and M_t denotes the total number of speeches given between meeting $t-1$ and t.

Figure 3 shows the evolution of the topic proportions for the main six topics extracted from the speeches of all FOMC members between 1997 and 2018. To convey the big picture on the average share of each topic, each topic proportion here is computed as a moving average of the proportions of the current and the respective previous seven FOMC meetings, i.e. roughly as an annual average proportion. As expected, the topic Economy takes the largest share as many of the speeches provide an overview of the prevailing economic conditions and outlook in a particular period. When combined, Economy and Monetary Policy account for roughly 40% to 50%, except during the financial crisis. Financial Stability and Supervision and Regulation combined make up for about 20%, and up to 35% combined with the Financial Conditions topic. The share of the Housing topic increases during the run-up to the financial crisis and falls below the pre-crisis level thereafter.

The smoothed topic proportions appear relatively stable up until the financial crisis of 2007-2008, with the Financial Stability and the Financial Conditions topics gaining importance between 2007 and 2010 and during the European sovereign debt crisis. Thereafter, we observe that the Monetary Policy topic takes over a larger share in speeches compared to before the crisis, which relates not only to the expansion of monetary policy tools but also to public discussions of challenges for monetary policy, exit strategies and normalization, especially in the speeches of FRB presidents.

Figure 3: Topic proportions, 1997 to 2018

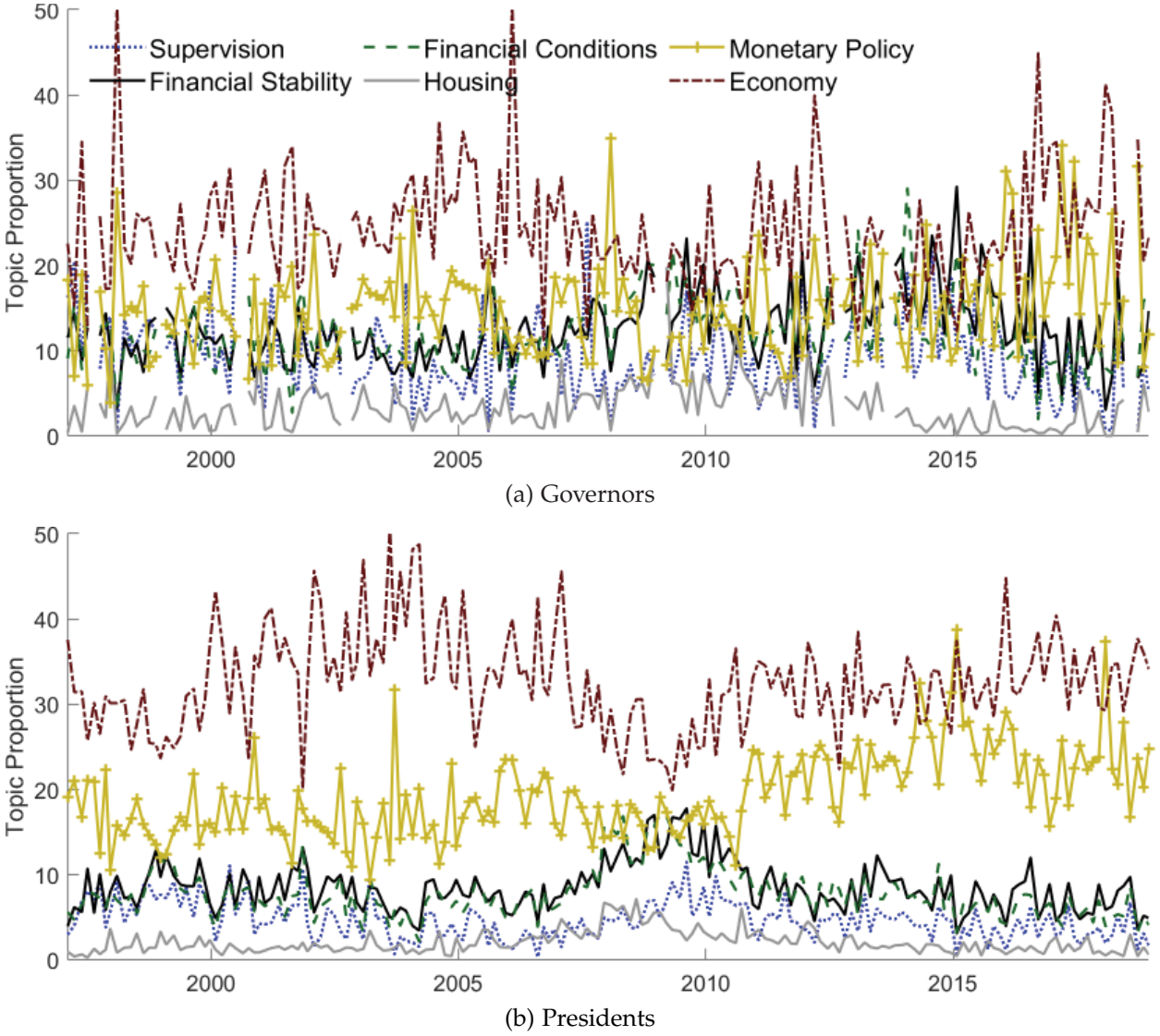


Note: The figure shows the proportion of the main six topics extracted from the Fed speeches for the period 1997 to 2018. The topic proportions displayed in the figure are the moving average of the respective seven previous and current FOMC meeting, i.e. roughly annual averages.

We looked at some examples of speeches that rank the highest on the topic proportion in selected topic categories (see Table A.1 in Appendix A) and observe that the topics Monetary Policy and Economy may individually take up to more than 60 percent of a speech, while the

topics Financial Stability and Supervision and Regulation very rarely exceed 40 percent. Speeches with highest topic proportions in Monetary Policy, Economy and Financial Stability are mostly given by FRB presidents. In contrast, speeches with the highest proportion on the Supervision and Regulation topic are all given by Governors.

Figure 4: Main topic proportions based on Fed speeches, 1997 to 2018



(a) Governors

(b) Presidents

Note: The figures show the topic proportions of Supervision and Regulation, Financial Stability, Financial Conditions, Housing, Monetary Policy and Economy at a FOMC meeting frequency. Panel (a) shows the results for speeches given by Governors, and Panel (b) shows the results for speeches given by all regional Fed Presidents.

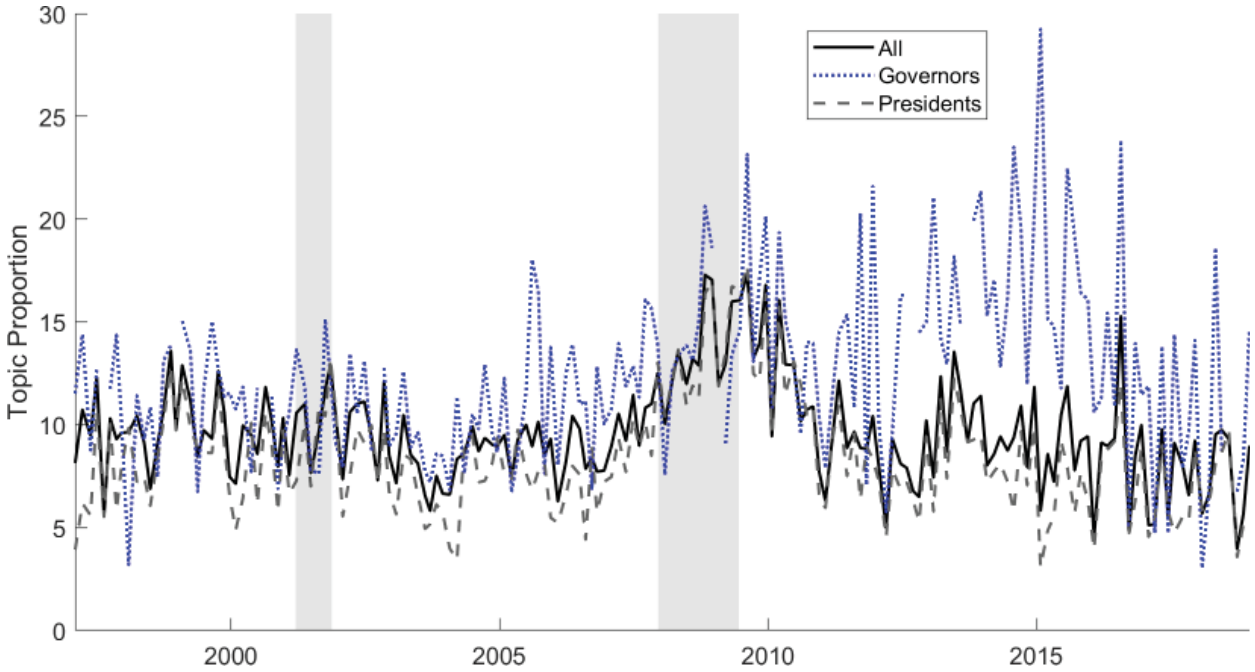
In Figure 4 we show the evolution of topics by type of speaker, with Governors in Panel (a), and FRB presidents in Panel (b), at a meeting frequency. Three main differences between these two groups are visible: i) FRB presidents have a higher topic proportion dispersion than Governors, ii) topic proportions exhibit smoother variation over time for FRB presidents than for Governors and iii) on average, Governors have a higher proportion on financial-related topics than FRB presidents.

In speeches by FRB presidents (Panel b), the Economy topic makes up for the highest share over time. Their speeches got more balanced in terms of topic shares only during the global

financial crisis, with the financial-related topics gaining also importance. In the aftermath of the crisis, Fed presidents became increasingly vocal about monetary policy. A more intense communication on monetary policy during this period corresponds with the introduction of new policy tools like forward guidance and balance sheet expansions. In contrast, the topic proportions of speeches by Governors (panel a) exhibit no strong time trends.

Overall, our topic modeling analysis uncovers some differences in topic communication between FRB Presidents and Governors. Among other factors, these differences might relate to the Fed's institutional design and to different responsibilities between the two groups. For instance, concerning monetary policy, all FRB presidents and Governors participate in the debate on the U.S. monetary policy as FOMC members and participants.[8] Unsurprisingly, a large part of their speeches concentrates on the economy and on monetary policy. In addition, the Board of Governors writes regulations and creates supervisory policy for the Federal Reserve System.[9] As part of their duties, Governors are also assigned to several Board Committees, among them the Committee on Economic and Monetary Affairs, the Committee on Financial Stability, and the Committee on Supervision and Regulation. This job "specialization" of Governors could explain why in terms of public communication, they have more specialized speeches and therefore a higher average proportion of them in financial-related topics.

Figure 5: Financial Stability topic proportion by type of speaker, 1997 to 2018



Note: The figure shows the Financial Stability topic proportion by type of speaker at a FOMC meeting frequency. The shadow areas in gray denote NBER recessions. Note that in eight cases, there were no speeches given between meetings by Governors. We treat this cases as missing values.

Figure 5 shows the evolution of the Financial Stability topic proportion at a meeting frequency conditional on the type of the speaker. As discussed above, we observe that in general, Governors

[8] All 12 Fed presidents participate in FOMC discussions, though only five are voting members at any point in time.

[9] Since 2010, the FOMC has also a vice chair for supervision, created by the Dodd-Frank Act 2010. The vice-chair for supervision leads the regulation and enforcement of banks and other financial institutions that the board supervises. However, many of the Fed's banking supervision/regulation activities are delegated to the Federal Reserve Banks.

have a higher speaking proportion on this topic than FRB presidents. The correlation between the topic indicators of these two groups is around 29%, and the difference is especially striking after the financial crisis. It is worth noting that the period 2012-2016, for which the difference is at its maximum, coincides with a period of implementation of new US banking and supervisory regulation.

2.4 Topic Tone

Although our topic proportion measures already provide interesting insights about the content of Fed speeches, they do not convey information on the tone of speeches. In the following, we compute a measure of the tone or sentiment expressed in Fed speeches over time.

Our tone indicator is based on a dictionary approach, i.e. we count pre-specified words, mainly adjectives, in a text. Several dictionaries have been proposed in the literature, and given that we are interested in financial-related communication in central banks, we opt for the dictionary developed by Correa et al. (2021). The authors built a list of positive and negative words related to financial stability by reading financial stability reports of about 64 central banks and multilateral institutions. We, therefore, make the identifying assumption that the language used to express sentiment about financial-related issues in central bank speeches is sufficiently similar to the language in financial stability reports.

We focus on a measure of *negative tone* for two reasons.[10] First, the vocabulary of Correa et al. (2021) is asymmetric, i.e. it includes 295 negative words and only 96 positive words. Second, there tends to be more use of negated positive words in the English language, such as "not stable" or "not favorable", than negated negatives, such as "not shrinking" or "not vulnerable". This means that the probability of incorrectly counting negated positives as positives is higher than the probability of counting negated negative words as negative.

The methodology we use to construct our tone indicator is similar to that of Hansen and McMahon (2016). Each sentence for which at least a share of $\alpha = 10\%$ of the sentence's total words is about topic k, considering only the four financial-related topics, is classified as being a sentence belonging to topic k, which we label *k-sentence*. We count then the negative words within each *k-sentence*, and rescale them by the total number of words in the sentence:[11]

$$\text{Negative Tone}_{k,d} = \text{NT}_{k,d} = \sum_{j=1}^{J_d} r_{k,d,j}^{(-)}, \tag{3}$$

where J_d denotes the number of *k-sentences* in speech d and $r_{k,d,j}^{(-)}$ denotes the number of negative tone words as a share of the total words in sentence j.

Differently from other papers that have looked at the tone of homogeneous texts, such as Hansen and McMahon (2016), who analyzed monetary policy statements, and Correa et al. (2021), who considered financial stability reports, our corpus is highly heterogeneous. Each of the speeches we consider can (i) cover a variety of topics, (ii) do so with a changing intensity of

[10] See Loughran and McDonald (2011) for a similar discussion.

[11] To build the financial stability tone measure, differently from Wischnewsky et al. (2019) who also used the same dictionary, we apply the Correa et al. (2021) dictionary only on financial stability related sentences while the former apply it to the entire texts of the Congressional hearings that, as shown in their paper, are in general only 10% about financial stability.

financial stability or other financial-related issues, and (iii) our final measure is computed at a meeting frequency, which implies that more than one speech (document) is available for each meeting. Therefore, and unlike the papers mentioned above, to deal with the heterogeneity in speeches, we weigh the tone measure of a speech by its respective topic intensity. In detail, to get a NT index at meeting frequency, we aggregate the tone of all speeches given between meetings by weighting them with the topic intensity of the respective speech:

$$\text{Negative Tone}_{k,t} = \frac{1}{M_t} \sum_{d \in m_t} \text{NT}_{k,d} * \text{TI}_{k,d}, \tag{4}$$

where t is at meeting frequency, m_t denotes the set of speeches given between meeting $t-1$ and t, M_t denotes the total number of speeches given between meeting $t-1$ and t, and $\text{TI}_{k,d}$ denotes the topic intensity which is computed as the share of topic k terms in speech d.[12] As explained above, we weight by the topic intensity of the speech to mitigate the impact of speeches that are not mainly on topic k issues, i.e. the tone of speeches that are actually topical receives relatively more attention in our measure. We additionally divide by the number of speeches to avoid that more (less) speeches necessarily imply a more (less) negative tone indicator. Note that given eq. (4) the tone indicator can also be interpreted as a tone-refined version of the topic proportion measure presented in Section 2.3, i.e. a topic proportion indicator reweighted by its own tone at the speech level.

Table A.2 shows the top five speeches in terms of negative tone for the four financial stability-related topics. First, although the topic proportion plays a role in our tone measurement calculation, there is some added value in the tone indicator. For the FS topic, for example, only one of the five speeches is in the top five of the topic proportions in Table A.1. For the S&R topic, none of the first five speeches for negative tone coincide with the top five of the Table A.1. Interestingly, all but one of top negative speeches are from FRB presidents. The Boston Fed President Rosengreen stands out among the presidents with the most negative speeches on financial issues. While Governors speak more on S&R because of their job responsibilities, the most negative speeches on the subject are all from a FRB president. This is in line with what will be discussed later, i.e. communication by Governors is generally classified in the neutral zone, less likely to generate "news" and to move markets.

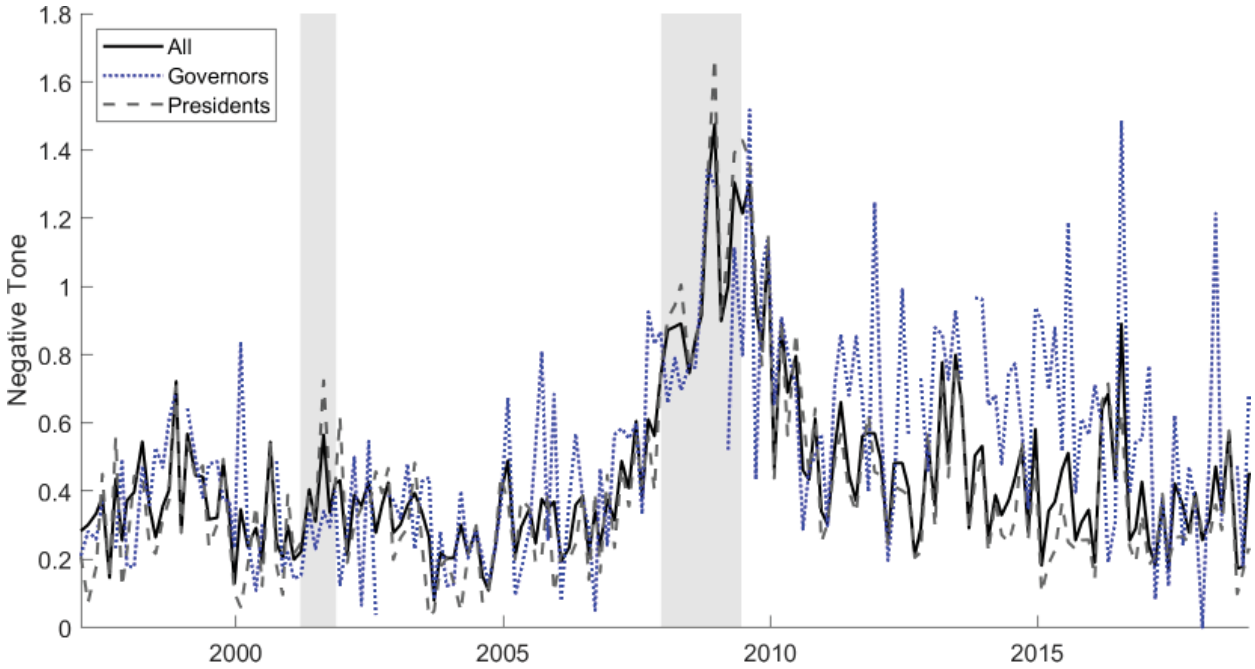
Figure 6 shows the tone indicator related to the Financial Stability topic, at a meeting frequency, conditional on the type of the speaker. We observe that the tone on this topic was markedly negative during the global financial crisis of 2007-2009. The increase in the negative tone in speeches after the global financial crisis likely reflects two different factors: (i) in this period there was an increase in speeches on lessons on financial stability "a decade after the crisis", which does not reflect real-time negative sentiment, and (ii), in the period before and during the normalization of monetary policy, some speeches were discussing the challenges that a low rate environment poses for financial stability, which might have contributed to the negative tone.

The correlation between the Financial Stability negative tone and the topic proportion is high, i.e. 84% for the indicator based on speeches by all members, 75% for speeches by Governors and 88% for speeches by FRB presidents. This high correlation is partly due to the construction

[12] Weighting by $\text{TP}_{k,d}$, the topic proportion based on eq. (1), leads to qualitatively similar results, but produces an index with a few outliers.

of the tone measure but also because many of the terms in the Financial Stability topic already convey a negative sentiment. Thus, an increase in Financial Stability talk takes generally place in stress periods, and with a negative tone. However, since the Correa et al. (2021) dictionary is based mainly on adjectives and not nouns (unlike our topic words dictionary), the tone measure might nonetheless provide complementary information to our measure of Financial Stability topic proportion. We will investigate this possibility in the following section.

Figure 6: Financial Stability negative tone by type of speaker, 1997 to 2018



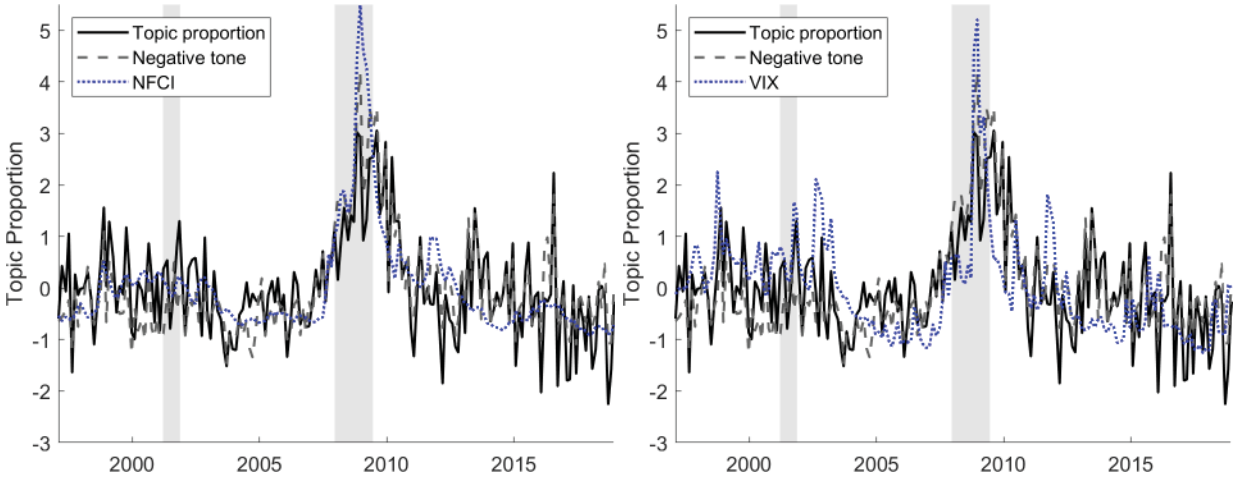
Note: The figure shows the Negative Tone indicator for the Financial Stability topic computed by type of speaker, as described in (4), at a FOMC meeting frequency. The shadow areas in gray denote NBER recessions.

2.5 Comparison with market-based indicators

As a first step to assess the informational content of our speech-based topic and tone indicators, we compare them to market-based measures of financial conditions and financial stress. Although there exists a variety of indices of financial stress and financial conditions that are based on market data, we focus here on two well-known indicators: the National Financial Conditions Index (NFCI) of the Chicago Fed and the Chicago Board Options Exchange Volatility Index (VIX). The NFCI is computed using a factor model and a large number of financial series, and published by the Chicago Fed. The VIX in turn is a well-known, widely used and purely market based measure of volatility in stocks listed in the S&P 500. Both indices typically spike during times of financial turmoil.

Figure 7 plots the FS topic and tone indicators against the NFCI and VIX (all series are standardized). The topic proportion (solid line) and the tone measure (dashed line) are more volatile than the NFCI and the VIX (dotted lines), but their evolution is relatively similar around important economic and financial events, such as the Dotcom bubble or the Great Financial crisis. Overall, a visual inspection confirms that the financial stability speech-based indicators reflect, in part, financial market developments but there is also individual variation. The correlations between the FS topic proportion and the NFCI and VIX are 59% and 45%, respectively. The correlations between the FS tone measure and the NFCI and VIX are 75% and 47%.

Figure 7: FS speech-based vs market-based financial indicators



(a) NFCI vs speech-based measures

(b) VIX vs speech-based measures

Note: Panel (a) plots the NFCI (dotted line) against the Financial Stability topic proportion indicator (solid line) and the Financial Stability sentiment indicator (dashed line). Panel (b) plots the VIX (dotted line) against the Financial Stability topic proportion indicator (solid line) and the Financial Stability sentiment indicator (dashed line). All series are standardized.

3 Monetary policy implications of financial stability communication

The FOMC has stressed, in particular since the Great Recession, that financial vulnerabilities and financial stability risks are a consideration for achieving the Fed's dual mandate. In the absence of an institutionalized communication channel on the monetary policy implications of financial vulnerabilities, this section investigates empirically if financial-related communication in Fed speeches provides valuable information in this direction. Therefore, we estimate an interest rate reaction function that links the endogenous response of monetary policy to macroeconomic conditions, in the spirit of Taylor (1993), and to our financial-related communication measures. As a benchmark interest rate reaction function, we consider a standard version of the Taylor rule that uses real-time measures of the Federal Reserve Board staff's forecast of macroeconomic conditions, the so-called Greenbook forecasts, as in Orphanides (2003). The baseline Greenbook forecast-based Taylor rule takes the following form:

$$i_t = c + \phi_i i_{t-1} + \phi_\pi E_{t^-} \pi_{t+4} + \phi_x E_{t^-} x_{t+4} + u_t, \tag{5}$$

where t is the time index at a meeting frequency, i_t is the target Federal Funds Rate (FFR) set at each FOMC meeting, c is the intercept, $E_{t^-}\pi_{t+4}$ is the Greenbook forecast of annualized quarter-on-quarter CPI inflation four quarters ahead, $E_{t^-}x_{t+4}$ is the Greenbook forecast for the output gap four quarters ahead, and E_{t^-} denotes the expectations formed right before the FOMC meeting. This version of the Taylor rule includes also a smoothing term for the FFR.[13] All variables are expressed in percent.

[13]Since all right-hand variables are available prior to the interest rate decision, we estimate this Taylor rule by least squares as in Coibion and Gorodnichenko (2012). We follow Coibion and Gorodnichenko (2012) and use heteroskedasticity and autocorrelation robust standard errors (HAC) based on the Bartlett kernel of Newey and West (1987), with a lag length of $0.75T^{1/3}$, where T denotes the sample size.

Greenbook forecasts are made available to the public with a delay of five years, which constrains our data sample to the period from 1997, the start of our speech data set, to the end of 2013, the latest available Greenbook forecasts. Due to the potential confounding impact of the financial crisis and the subsequent Great Recession, we further split the sample into two parts: one for the pre-Great recession period, from January 1997 to November 2007 – reflecting the NBER business cycle classification – and one for the full available sample, from 1997 to 2013. Since the policy rate was kept at the zero lower bound (ZLB) from December 2008 to December 2015, we use the shadow rate as the dependent variable, based on Wu and Xia (2016), for the full sample specification. The shadow rate aims at measuring the monetary policy stance even when the policy rate is at the ZLB. It is equal to the effective fed funds rate until the policy rate reached the ZLB, and can become negative afterwards, reflecting the Fed's additional easing through unconventional policies.

Results of the baseline specification (5) for the pre-crisis period are shown in Table 2, column (1). The coefficients for CPI inflation and the output gap forecasts have the expected sign and are found to be relevant predictors, i.e. the Federal Reserve responds significantly to changes in its forecasts. The estimated reaction of the Fed to the forecasted inflation is significantly greater than one (the long-run estimate $\phi_\pi = 0.22/(1-0.876) = 1.77$). This implies that the Taylor principle, with the nominal interest rate responding more than one-for-one to inflation, is satisfied. An additional one percentage point in the annualized four-quarter ahead CPI inflation forecast leads to an increase of the FFR by about 22 basis points on impact. Similarly, an additional one percentage point in the output gap forecast leads to an increase of the FFR of about 14 basis points on impact.

3.1 A Taylor rule augmented with communication indicators

To assess whether the content of speeches given by FOMC members contains useful information for the policy rate reaction function, we augment the baseline Taylor rule with financial-related communication measures. In the following, when presenting the results, we will focus on the Financial Stability (FS) topic first and then comment on the other financial-related topics of interest: Financial Conditions, Supervision and Regulation, and Housing. Our speech-augmented Taylor rule takes the following form:

$$i_t = c + \phi_i i_{t-1} + \phi_\pi E_{t^-} \pi_{t+4} + \phi_x E_{t^-} x_{t+4} + \phi_{\text{TP}} \text{TP}_t + \phi_{\text{NT}} \text{NT}_t + u_t, \tag{6}$$

where TP_t represents the topic proportion computed as in equation (2), and NT_t the negative tone as constructed in equation (4). The timing of the two indicators is such that they are computed using all speeches given before the meeting at time t but after the previous meeting at time $t-1$.

Financial stability topic: Results of the augmented Taylor rule for the FS topic for the pre-Great recession period are shown in columns (2) to (4) of Table 2. We find that both FS topic proportion and tone are statistically and economically relevant predictors of interest rate changes. An increase of the topic proportion indicator by one percentage point is, on average, associated with a reduction in the policy rate by about 4.8 basis points on impact. Due to the interest rate smoothing, a one percentage point increase implies a long-run effect on the FFR of about 38 basis points, above the typical rate step-size of the Fed of 25 basis points. The roughly four

percentage point increase of the topic proportion in 2007, occurring during the run-up to the financial crisis, was, on average, associated with a reduction in the policy rate by 19 basis points in the short-run, or about a fourth of the 75 basis points FFR cut that occurred between January 2007 and November 2007.

Extrapolating these results for the entire financial crisis – when the topic proportion indicator increased by about six and half percentage points – would imply a reduction of the FFR by around 250 basis points in the long-run; this explains about half of the roughly 500 basis point reduction that occurred until December 2008. That the topic proportion explains up to 50% of the FFR reduction in this period, likely reflects the fact that some of the major downward forecast revisions of the Greenbook occurred relatively late, starting at the end of 2008, while stress in the financial system materialized much earlier. Hence, a monetary policy reaction function that factors in financial stability considerations, in a timely manner, helps to explain important monetary policy decisions during this period.

Table 2: Taylor rule results — baseline specification

	FFR	FFR	FFR	FFR	SR	SR	SR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
r_{t-1}	0.876***	0.877***	0.881***	0.878***	0.931***	0.930***	0.932***
	(0.031)	(0.030)	(0.034)	(0.031)	(0.027)	(0.029)	(0.027)
$CPI_{t,h=4}$	0.219*	0.278**	0.243**	0.276**	0.193***	0.195***	0.197***
	(0.112)	(0.110)	(0.116)	(0.111)	(0.072)	(0.072)	(0.072)
$OG_{t,h=4}$	0.143***	0.139***	0.139***	0.139***	0.045**	0.039	0.041
	(0.046)	(0.039)	(0.045)	(0.040)	(0.022)	(0.027)	(0.028)
FS Proportion		−0.048***		−0.042*	−0.028**		−0.020
		(0.016)		(0.022)	(0.013)		(0.027)
Neg. Tone			−0.509***	−0.119		−0.280*	−0.110
			(0.175)	(0.223)		(0.162)	(0.329)
AIC	-7.9	-17.34	-12.53	-15.56	33.21	34.04	34.89
SIC	4.37	-2.61	2.19	1.63	50.69	51.52	55.28
Observations	86	86	86	86	136	136	136
Adjusted R^2	0.985	0.987	0.986	0.987	0.990	0.990	0.990

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007, and January 1997 to December 2013, as indicated by the column names FFR and SR respectively. FFR denotes the target Federal Funds Rate, whereas SR denotes the shadow rate of Wu and Xia (2016). The FS topic proportion and the negative tone indicator where computed based on speeches of all FOMC members. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

With regard to the FS tone, in the pre-crisis period, a one standard deviation increase in the negative tone indicator is associated with a reduction of the policy rate by about 6.6 basis points. Once we include both measures in the regression, the coefficient for the tone measure becomes insignificant while that of FS proportion remains unchanged (column 4). This suggests the two indicators convey similar information in the case of the Financial Stability topic, whose communication generally increases in times of stress and negative financial developments. As discussed earlier, in our setup, this topic mainly reflects financial stability concerns, e.g.

communication about excessive behaviour in financial markets or vulnerabilities in the financial system.

Although the adjusted R^2 changes little from one specification to another, the Akaike Information Criteria (AIC) and the Schwarz Information Criteria (SIC) prefer the Taylor rule specification that makes use of FS topic proportion only. This will hence be our preferred specification for the remainder of the paper.

Columns (5) to (7) of Table 2 report the results for the full sample ranging from 1997 to 2013, using the shadow rate of Wu and Xia (2016) as dependent variable. These results confirm that the FS topic measure is a more relevant predictor than the FS tone. However, the changes in the coefficient estimates, in particular the sharp reduction in the output gap coefficient, point to potential structural breaks occurring around the financial crisis.

Other financial-related topics: Results for the topics Supervision and Regulation (S&R) and Financial Conditions (FC) are qualitatively in line with those for the FS topic (see Tables B.1 and B.3 in Appendix B).[14] Both topic proportions' coefficients are significant, have a similar size and a negative sign. Results are also comparable for both the pre-crisis and the whole sample period using the shadow rate. The main difference is that the tone-specific measures are stronger in magnitude and remain significant when both speech-based indicators are included in these specifications (see column 4 in respective tables), compared to the FS case. The tone indicator might be better suited for these topics because their corresponding topic words do not have the same negative connotation as the words of the FS topic.

Interestingly, an increase in the speaking share about Supervision and Regulation also relates to a more accommodative monetary policy. This suggests that the FOMC could have talked about supervision and regulatory policies but used monetary policy as well to counteract adverse consequences of financial risks for the economy. This idea is reflected in a recent FOMC discussion:

> *Recognizing these limitations [of countercyclical macroprudential tools], many participants remarked that the Committee should not rule out the possibility of adjusting the stance of monetary policy to mitigate financial stability risks, particularly when those risks have important implications for the economic outlook and when macroprudential tools had been or were likely to be ineffective at mitigating those risks.*
>
> — FOMC minutes, January 2020

We also report results for the Housing topic (see Table B.5 in Appendix B). While the evidence is somewhat weaker, the topic proportion enters significantly in the Taylor rule in the pre-crisis sample, but with a positive sign: an increase in the proportion of the Housing topic in Fed speeches is associated with an increase in the FFR.

Overall, our results are in line with the recent literature. Despite differences in the type of communication considered for the analysis (public speeches in our paper versus FOMC meeting transcripts in Peek et al. (2016) and semiannual Congressional hearings in Wischnewsky et al. (2019)), different samples and different text-based measures, we confirm that FS concerns coincide

[14] Appendix B shows results for the Taylor rule equation (6) augmented alternatively with topic proportion and tone-specific measures for the three other financial-related topics: Regulation and Supervision (S&R), Financial Conditions (FC) and Housing.

with a more accomodative monetary policy. The Fed has adjusted its policy stance by reacting to existing financial stability risks, rather than acting pre-emptively to prevent the build-up of such risks. In other words, the Fed has been more a *cleaning* than a *leaning against the wind* type of central bank (as also discussed in Friedrich et al. (2019) for a sample period similar to ours and in White (2009)). This stance is observed in a time period where effective macroprudential tools in the U.S. were lacking, especially before the GFC (Dudley, 2015). Interestingly, our dis-aggregated topic analysis reveals a *leaning* attitude of the Fed against housing market developments in the period before the GFC, since a higher speaking time on Housing is positively associated with FFR movements.

In the remainder of the paper, we will focus on the pre-GFC period (1997-2007), for which results based on all financial-related topic measures have shown to be particularly strong and significant.

3.2 Taylor rule regressions with market-based financial controls

As mentioned earlier, a variety of market-based financial stress and financial conditions indicators exists that could be part of the information set of FOMC members when deciding on monetary policy. We now formally test whether text-based and marked-based indicators contain the same information for monetary policy decisions. We consider several financial indicators, widely used in the literature and by practitioners. The list includes the VIX, the NFCI of the Chicago Fed, the adjusted NFCI (ANFCI), the Kansas City Financial Stress Index (KCFSI), the Goldman Sachs U.S. Financial Conditions Index (GSFCI) and the Excessive Bond Premium (EBP) based on Gilchrist and Zakrajšek (2012). We provide definitions and sources for these indicators in Table A.3.

It is worth noting that all indicators, beside the VIX and the GSFCI, became publicly available after or during the global financial crisis.[15] As such, these synthetic indicators may not have been part of the FOMC's real-time (pre-financial crisis) information set, although most of the underlying financial variables were. These indicators are available at different frequencies: for those available on a weekly basis (or at a higher frequency), we computed the four week average prior to the respective FOMC meetings.[16]

To evaluate whether the FS topic proportion has predictive power beyond the information embedded in the financial indicators described above, we run our preferred Taylor rule specification including both text-based and market-based indicators. Results, displayed in Table 3, show that the coefficient of the FS topic proportion remains significant in each regression, and similar in size to that of the baseline regression in Section 3.1. Interestingly, coefficients of market-based financial indicators are also negative and significantly different from zero (except for the ANFCI).[17]

These results confirm that our speech-based measure provides information for FFR changes, beyond the effect of market-based financial indicators. One possible explanation is that our approach takes into account the fact that Fed officials likely form their beliefs about financial

[15] The VIX in its current format started to be computed in 2003, and earlier versions based only on the S&P 100 started as early as 1993. The GSFCI is based on the paper by Dudley and Hatzius (2000), and thus has been available from around 2000.

[16] Note that financial indicators are potentially at an informational advantage of about ten days due to the blackout period on Fed communication. The blackout period begins on the second Saturday before the beginning of the FOMC meeting and end on the next day after the meeting, unless otherwise noted.

[17] Note that the scaling of the indices is different, i.e. a direct comparison between the coefficients is not possible.

stability by paying attention to an evolving set of financial and banking variables. These beliefs are then reflected in communication with the public and in policy decisions.

Table 3: Pre-crisis period results with different financial indicators

	Dependent Variable: Federal Funds Target Rate					
	NFCI	ANFCI	KCFSI	VIX	GSFCI	EBP
	(1)	(2)	(3)	(4)	(5)	(6)
FFR_{t-1}	0.903***	0.893***	0.903***	0.886***	0.854***	0.893***
	(0.025)	(0.032)	(0.023)	(0.024)	(0.034)	(0.024)
$CPI_{t,h=4}$	0.190*	0.249**	0.193*	0.206**	0.339***	0.261**
	(0.110)	(0.112)	(0.109)	(0.103)	(0.116)	(0.110)
$OG_{t,h=4}$	0.137***	0.142***	0.133***	0.146***	0.094*	0.121***
	(0.038)	(0.042)	(0.036)	(0.032)	(0.052)	(0.040)
Financial Index	−0.500***	−0.094	−0.118**	−0.018***	−0.105*	−0.088*
	(0.150)	(0.079)	(0.046)	(0.004)	(0.060)	(0.052)
FS Proportion	−0.028**	−0.044***	−0.034**	−0.023*	−0.045***	−0.042***
	(0.013)	(0.015)	(0.013)	(0.012)	(0.017)	(0.016)
AIC	-29.14	-16.18	-26.45	-44.91	-19.54	-20.86
SIC	-11.96	1	-9.27	-27.73	-2.36	-3.68
Observations	86	86	86	86	86	86
Adjusted R^2	0.989	0.987	0.988	0.991	0.987	0.988

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, when additionally controlling for a financial indicator based on market data. The column name implies which indicator was used for the variable Financial Index in the regression. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

3.3 Does it matter who is speaking?

So far, our analysis suggests that communication on financial-related topics, preceding FOMC meetings, provides information on monetary policy decisions beyond the effects that such concerns could have on the forecasts for inflation and the output gap. A question that naturally arises is: does it matter whose speeches we consider — those by the Fed Chair, Governors, or the FRB presidents? To answer this question, we estimate the augmented Taylor rule (6) with the topic proportions computed using the speeches of each group, separately.

Results for the FS topic and the pre-crisis sample are reported in Table 4. Column (1) restates the baseline results of column (2) in Table 2 for comparison. Columns (2) to (4) show coefficients for regressions with group-specific topic proportions as indicated by the column name. The coefficient of the FS proportion for FRB presidents is the highest and closer to the estimate for the FOMC as a whole. Further, the AIC and SIC prefer the specification that uses an indicator that is based on FRB presidents over Governors or the Fed Chair. An increase by one percentage point in the FS proportion of FRB presidents is associated, on average, with a reduction of the FFR by about 3.8 basis points on impact, or about 30 basis points in the long-run.

The results for the topics of Supervision and Regulation and Financial Conditions are presented in Appendix B, where we focused on the tone instead of topic proportions since it was the

Table 4: Taylor rule results — pre-crisis period — by FOMC members

	Dependent variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.877***	0.873***	0.890***	0.876***
	(0.030)	(0.030)	(0.029)	(0.032)
$CPI_{t,h=4}$	0.278**	0.268**	0.260***	0.271**
	(0.110)	(0.112)	(0.099)	(0.121)
$OG_{t,h=4}$	0.139***	0.145***	0.141***	0.137***
	(0.039)	(0.044)	(0.047)	(0.039)
FS Proportion	−0.048***	−0.017**	−0.019***	−0.038***
	(0.016)	(0.008)	(0.005)	(0.014)
AIC	-17.34	-6.18	-9.64	-16.54
SIC	-2.61	8.26	4.11	-1.82
Observations	86	82	73	86
Adjusted R^2	0.987	0.985	0.986	0.987

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the financial stability topic proportion indicator was computed based on speeches of different subgroups of the FOMC, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

preferred specification in baseline regressions, as shown in Table B.1 and Table B.3. The relevance of the tone indicator is again driven by the speeches of presidents, as shown in Table B.2 and Table B.4. In addition, a specification that controls for both the FS and the Housing topic proportions, shown in Table B.6 in Appendix B, confirms that: i) the Housing coefficient is positive while that of FS remains significant and negatively related to FFR movements and, ii) the strongest signal comes from FRB presidents' speeches. Overall, results with respect to all financial-related topics provide strong evidence that there is information in the speeches of FRB presidents.

In the following, we discuss three potential explanations of why the communication of FRB presidents has a stronger signaling power for FFR changes compared to that of other FOMC members. The first one relates to the institutional design of the Federal Reserve System, which is comprised of the Board of Governors and the FRBs. This design might imply some constrains on communication. The second explanation relates to a potential strategic motive driving FRB presidents' communication. The third explanation considers potentially different information sets of FRB presidents in relation with their supervisory responsibilities.

Institutional Design: First, a greater informational content in the speeches could simply be due to a stronger signal if 12 Fed presidents talk between FOMC meetings (and about the same topic), compared to seven Board members (when all seats are filled and including the Fed Chair). Indeed, Figure 1 showed that Fed presidents on average have a higher number of speeches per year than Governors. More speeches could imply a stronger signal and, therefore, more explanatory

power in our Taylor rule estimations. Second, the predictive power could relate not only to the number of speeches but also to the combination of *what* is communicated and *when*. As discussed previously, a higher topic share on FS and S&R could relate to the specific responsibilities of Board of Governors. For instance, responsibilities of Governors on supervision and regulation likely imply a higher specialization of their speeches (see Table A.1, where the top five speeches on Supervision and Regulation were all given by Board members). This specialization seems to induce more focus on certain topics and less variation in the topic proportion over time, thus not generating "news".

Related with the institutional design, it could also be that the information in speeches of FRB presidents comes from speeches of the New York Fed president. The New York Fed has several unique responsibilities related to its function of being in charge of the implementation of monetary policy, which include conducting open market operations, intervening in foreign exchange markets, among others. The New York Fed also supervises the largest banks in the U.S. Financial markets and financial stability concerns are hence at the heart of its mission. Further, the New York Fed President is the only FRB president with a permanent voter status in the FOMC. Therefore, to test whether our results are driven by the instituitional role of the New York Fed president when it comes to finance related matters, we constructed a topic proportion indicator based on speeches of FRB presidents but excluding the New York Fed president.

Strategic communication of FRB presidents: FRB presidents do not always have a voting right in the FOMC decisions. In particular, FRB presidents vote on a rotating basis with only five bank presidents voting at a time. The president of the New York Fed has a permanent voting status, whereas the four others alternate on a one-year voting right basis. Communicating on a certain topic at a certain time could, therefore, be a strategic move of Fed presidents to reinforce their bargaining power in FOMC deliberations. This could be especially relevant when Fed Presidents have FOMC voting rights. At the same time, FOMC members without voting rights could have an incentive to steer the public debate before meetings to wield influence over the FOMC decision despite their lack of a voting right. Therefore, we test whether it is the communication on financial concerns of voters vs non-voters that provides extra information, by computing Financial Stability topic measures for these two groups (additionally excluding the NY Fed president from the group of voters for reasons discussed above). As the voting rights alternate yearly, so does the group of speakers used to construct the indicators.[18]

Different Information Sets: Further, we investigate whether the results in Table 4 are driven by the supervisory responsibilities of FRB presidents. While the Board of Governors has the authority and responsibility to carry out the supervision of financial institutions, it delegates the authority for the day-to-day supervisory activities to the FRBs. Within the Federal Reserve System, each FRB supervises financial institutions that are located within its district and, therefore, the total assets under supervision are markedly different across Reserve Banks. Consequently, we investigate whether the predictive content of speeches by presidents is different depending on the size of the banking assets under supervision. To do so, we classify Reserve banks as “High assets” versus

[18]This hypothesis is in the spirit of Ehrmann et al. (2019) that examined whether there is a difference in speech intensity and tone on monetary policy for voters and non-voters.

"Low assets". In particular, we compute the average total assets of commercial banks supervised in a given district over the years from 1997 to 2007, and thus obtain a ranking of Reserve Banks by asset supervision (based on data from the St. Louis Fed database FRED). Excluding the New York Fed, the five FRBs with the most assets under supervision are, in descending order, the Richmond Fed, the Chicago Fed, the San Francisco Fed, the Cleveland Fed, and the Atlanta Fed, which consequently constitute the "High assets" group of banks. The "Low assets" group consists of the Boston Fed, the St. Louis Fed, the Kansas City Fed, the Philadelphia Fed, the Minneapolis Fed, and the Dallas Fed.

To conduct a formal test of the importance of the New York Fed, and the *strategic interaction* and the *information set* channels dicussed above, we run individual regressions as in equation (6), where the topic proportions are computed on the respective subgroups of Fed Presidents: Fed Presidents without New York Fed, Voters, Non-Voters, High Asset FRBs and Low Asset FRBs. Results of these alternative Taylor rule estimations are provided in Table 5, columns (2) to (6), while column (1) presents the results for all FRB presidents, as in Table 4, for comparison.

Overall, we do not find a particular group-specific communication signal, when measured by their predictive power in a Taylor rule. In particular, we find that the importance of FRB presidents' communication about financial stability is not driven by speeches of New York Fed presidents. In contrast, the coefficient, shown in column (2), becomes larger and relatively more precisely estimated, when compared to the results for all presidents shown in column (1). Also, the information criteria prefer the specification using the indicator that does not make use of speeches given by the NY Fed president. The coefficients are slightly stronger for Voters and for the High Assets specifications, however we cannot draw a strong conclusion that either the New York Fed, or the strategic communication based on voting-rights or different information sets based on supervisory responsibility are driving the results.

More generally, our finding on FRB presidents can be related to what found by Kliesen et al. (2019), who show that markets react significantly on days when there are multiple FRB presidents speaking. Furthermore, from 2009 to 2013, the Macroeconomic Advisers LLC have consistently ranked the FRB presidents as the most impactful speakers (with the exception of the Chairman) when analyzing market reaction to speeches and giving the "Who moved the markets" award.[19] In contrast, Governors' speeches consistently ranked on the neutrality zone, not generating "news" and thus not moving markets.

Interestingly, FRB presidents are at times accused of cacophony by the financial press and market participants. For instance the Hutchins Center's survey on Fed communication found that 64 percent of respondents thought that FRB presidents should talk less (and let the Fed chair speak), see Olson and Wessel (2016). Instead, we show that Fed presidents' communication provides useful information for policy decisions according to a standard monetary policy reaction function, i.e. there is a policy signal in their public remarks.

[19] Macroeconomic Advisors rank each year FOMC members by the effects of their communication (speeches, television and radio interviews, and Op-Ed articles) on the two-year (ten-year after 2012) U.S. Treasury yield.

Table 5: Taylor rule results — pre-crisis period — additional results

	Dependent variable: Federal Funds Target Rate					
	Presidents	w/o NY	Voters	Non-Voters	High Assets	Low Assets
	(1)	(2)	(3)	(4)	(5)	(6)
r_{t-1}	0.876***	0.881***	0.878***	0.878***	0.883***	0.873***
	(0.032)	(0.030)	(0.032)	(0.031)	(0.029)	(0.031)
$CPI_{t,h=4}$	0.271**	0.253**	0.235**	0.233*	0.226**	0.235*
	(0.121)	(0.116)	(0.115)	(0.120)	(0.107)	(0.120)
$OG_{t,h=4}$	0.137***	0.134***	0.139***	0.143***	0.144***	0.140***
	(0.039)	(0.035)	(0.040)	(0.038)	(0.041)	(0.040)
FS Proportion	−0.038***	−0.049***	−0.030***	−0.026**	−0.031**	−0.016***
	(0.014)	(0.014)	(0.011)	(0.012)	(0.013)	(0.006)
AIC	-16.54	-22.9	-18.19	-11.31	-14.83	-7.98
SIC	-1.82	-8.17	-3.67	3.28	-0.11	6.46
Observations	86	86	83	84	86	82
Adjusted R^2	0.987	0.988	0.987	0.986	0.987	0.985

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the financial stability topic proportion indicator was computed based on speeches of different subgroups of Fed presidents, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

3.4 Robustness checks

In the following, we show that our results are robust to alternative Taylor rule specifications and computations of the speech-based topic indicators.

Alternative control variables in Taylor rule regression: Whereas Greenbook forecasts used in the Taylor rule have a specific forward-looking horizon (four-quarter-ahead), the speech-based indicators could be referring to past, current or future developments. Therefore, the text-based indicator could have an informational advantage over the Greenbook forecasts by supplying information about both the current and future state. Consequently, we estimate a Taylor rule with output gap and CPI Greenbook nowcasts instead of four-quarter-ahead projections. Table C.1 in Appendix C shows that the results remain robust relative to the baseline specification.

In two additional robustness checks, we augment our baseline Taylor rule regression with the Economy and the Monetary Policy topic indicators, respectively, to exclude the possibility that the speech-based financial indicator is not merely a substitute for important information about economic conditions that is revealed in speeches but not reflected in the Greenbook projections. Said differently, with this specification we test how much is left for FS topic once we control for the Economy and the Monetary Policy topic indicators. Results are shown in Tables C.2 and C.3 in Appendix C. The estimated coefficients for the Economy and Monetary Policy indicators are small and statistically insignificant. More importantly, the estimated coefficient for the FS topic indicator remains virtually unchanged.[20]

[20] In unreported results, we run the same Taylor rule regressions as in Table 4 but using the topic proportions of Community and Research, respectively, as a placebo test. As expected, we do not find that these two topic proportions are systematically associated with policy rate changes.

Alternative computations of the speech-based indicators: Besides the robustness checks on the Taylor rule specification, we also computed two alternative topic proportion indicators to show that results are not affected by some computation choices described in Section 2.2. The first alternative topic indicator leaves out step three, where we augmented the list of the words of the LDA-defined topics with unmatched LDA words. Instead, we directly take the topic-document distributions of the LDA and aggregate them via eq. (2) to get an indicator at a meeting frequency. Results of Taylor rule regressions with the alternative indicator are displayed in Table C.4 and are robust.

The second alternative topic indicator is also computed directly from the topic-document distribution of the LDA as above. However, in the preprocessing step, we additionally stem the corpus. Stemming is mainly used to reduce the dimensionality of data, as it only considers the root (or stem) of the words. Results of our Taylor rule regressions for this alternative computation are displayed in Table C.5 and are again in line with our baseline results.

4 Concluding remarks

The Federal Reserve does not have an institutionalized communication strategy regarding the monetary policy implications of financial stability concerns. Therefore, in this paper, we investigate the communication of FOMC members on financial stability-related topics by analyzing their speeches. This type of communication has the advantage of being a flexible medium to express concerns and, therefore, to reflect the diversity of opinions held within the Fed.

We assessed the speeches' informational content in a monetary policy reaction function and found that communication through speeches on financial-related issues is informative about upcoming monetary policy decisions by the Fed. A higher speaking time (topic proportion) or a higher negative tone on Financial Conditions, Financial Stability and Supervision and Regulation correlate with a more accommodative monetary policy stance while communication on Housing with a tighter policy stance. We interpret these results as evidence that the Fed has acted as a *cleaning*-type of central bank with respect to most dimensions of financial stability. When considering stability concerns on the housing market, the Fed appears more as a *leaning*-type.

Moreover, by looking at the speeches of different subgroups of FOMC members, we uncover several differences in the communication patterns and the explanatory power for policy decisions between Governors and FRB presidents; speeches by Fed presidents seem to convey timely and strong information for financial-related concerns and the likely direction of monetary policy.

We conclude that an institutionalized and frequent communication that conveys the FOMC's assessments of financial vulnerabilities, and their potential implications for the monetary policy could be beneficial to make the policy reaction function of the Federal Reserve more transparent in the future.

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Appendix A Tables

Table A.1: Topic proportions - Top 5 Speeches during 1997-2018

Date	Institution	Speaker	Title	Topic Proportion
			Monetary Policy	
2/16/2016	St. Louis Fed	J. Bullard	Comments on the FOMC's Amendments to its Statement on Longer-Run Goals	65.4
12/14/2017	Chicago Fed	C. L. Evans	Rationale for My Dissent at the December 2017 FOMC Meeting	65.0
03/01/2005	Richmond Fed	Jeffrey M. Lacker	Inflation Targeting and the Conduct of Monetary Policy	60.1
4/14/2015	Minneapolis Fed	N. Kocherlakota	Clarifying the Objectives of Monetary Policy	59.4
11/30/2018	New York Fed	John C.Williams	Monetary Policy Strategies for a Low-Neutral-Interest-Rate World	59.3
			Economy	
02/11/2003	Atlanta Fed	Jack Guynn	The State of the Recovery	67.1
11/27/2001	Board	Laurence H. Meyer	Before and after	66.7
05/06/2011	New York Fed	William Dudley	Regional Economy and Current Trends in Regional Employment	63.3
11/14/2006	St. Louis Fed	William Poole	U.S. Labor Input in Coming Years	62.6
03/26/2012	Board	Ben S. Bernanke	Recent Developments in the Labor Market	62.5
			Financial Stability	
11/07/2013	New York Fed	William Dudley	Ending Too Big to Fail	38.5
10/18/2013	New York Fed	William Dudley	Title II Resolution, a Useful Tool but Not a Panacea	37.3
05/09/2013	Richmond Fed	Jeffrey M. Lacker	Ending 'Too Big to Fail' Is Going to Be Hard Work	37.2
11/15/2016	Board	Stanley Fischer	Is There a Liquidity Problem Post-Crisis?	37.0
04/09/2013	Board	Daniel K. Tarullo	Regulating Systemic Risk	36.6
			Supervision and Regulation	
11/13/2003	Board	Roger W. Ferguson, Jr.	The Proposed U.S. Approach to Regulatory Capital: An Update	41.5
06/10/2003	Board	Roger W. Ferguson, Jr.	Basel II: Scope of application in the United States	40.4
03/14/2005	Board	Susan Schmidt Bies	Bank Secrecy Act and Capital Compliance Issues	39.4
09/26/2005	Board	Susan Schmidt Bies	Basel II Developments in the United States	38.0
05/16/2005	Board	Mark W. Olson	Basel II	37.8

Note: The table shows the speeches with the largest topic proportion share for Monetary Policy, Economy, Financial Stability and Supervision and Regulation.

Table A.2: Topic Tone - Top 5 Speeches during 1997-2018

Date	Institution	Speaker	Title	Tone measure
			Financial Stability	
11/07/2013	New York Fed	William Dudley	Ending Too Big to Fail	4.4
04/04/2016	Boston Fed	Eric S. Rosengren	Perspectives on Risks - Both Economic and Cyber	4.2
05/01/2009	Saint Louis Fed	James Bullard	The U.S. Financial System and Macroeconomic Performance	4.2
10/02/2008	Saint Louis Fed	James Bullard	Systemic Risk and the Macroeconomy: An Attempt at Perspective	4.1
06/30/2009	Kansas Fed	Thomas Hoenig	Capitalism and the Process of Renewal	4.0
			Supervision and Regulation	
07/01/2009	Saint Louis Fed	James Bullard	As In the Past, Reform Will Follow Crisis	4.0
12/08/1999	Chicago Fed	Michael Moskow	Pursuing Prosperity for All	3.7
03/02/2009	Boston Fed	Eric S. Rosengren	Addressing the Credit Crisis and Restructuring the Financial Regulatory System: Lessons from Japan	3.7
09/30/2010	Kansas Fed	Thomas Hoenig	TARP recipients and dividend payments	3.0
11/10/2009	Boston Fed	Eric S. Rosengren	Can We Ensure that Global Banks Do Not Create Global Problems?	2.7
			Financial Conditions	
3/2/2009	Boston Fed	Eric S. Rosengren	Addressing the Credit Crisis and Restructuring the Financial Regulatory System: Lessons from Japan	3.7
02/29/2008	Atlanta Fed	Dennis Lockhart	Thoughts on the Subprime Mortgage Crisis	3.1
05/16/2006	New York Fed	Timothy Geithner	Implications of Growth in Credit Derivatives for Financial Stability	3.0
02/01/2013	New York Fed	William Dudley	Fixing Wholesale Funding to Build a More Stable Financial System	2.8
02/29/2008	Boston Fed	Eric S. Rosengren	The Mortgage Meltdown - Implications for Credit Availability	2.7
			Housing	
5/30/2008	Boston Fed	Eric S. Rosengren	Current Challenges in Housing and Home Loans: Complicating Factors and the Implications for Policymakers	2.4
9/2/2010	Boston Fed	Eric S. Rosengren	Remarks at the Federal Reserve Conference on REO and Vacant Property Strategies for Neighborhood Stabilization	2.0
1/6/2012	New York Fed	William Dudley	Housing and the Economic Recovery	1.6
12/3/2007	Boston Fed	Eric S. Rosengren	Subprime Mortgage Problems: Research, Opportunities, and Policy Considerations	1.6
01/07/2012	Board	Sarah Bloom Raskin	Creating and Implementing an Enforcement Response to the Foreclosure Crisis	1.4

Note: The table shows the speeches with the largest negative tone for Financial Stability, Supervision and Regulation, Financial Conditions and Housing.

Table A.3: Financial indicators based on market data

Abbreviation	Data source	Description
NFCI	FRED	The NFCI, based on Brave and Butters (2012), provides a weekly indicator on U.S. financial conditions in money markets, debt and equity markets and the traditional and "shadow" banking systems, using around 100 financial variables.
ANFCI	FRED	The Adjusted NFCI (Brave and Butters, 2012) is based on the NFCI but controls for macroeconomic conditions. Since macroeconomic and financial variables are often highly correlated, the ANFCI provides a "financial-only" index.
KCFSI	FRED	The Kansas City Financial Stress Index (KCFSI), based on Hakkio and Keeton (2009), provides a monthly indicator for stress in the market based on 11 financial variables, which aims at specifically capturing the following channels: increased uncertainty about fundamental values, increases in asymmetric information, flight to quality and flight to liquidity.
VIX	FRED	The VIX, provided by the Chicago Board Options Exchange, is based on (forward-looking) implied volatilities of S&P 500 options that provide a measure of market risk and investors' sentiment.
GSFCI	Bloomberg	The Goldman Sachs U.S. Financial Conditions Index (GSFCI), first introduced in Dudley and Hatzius (2000), is a weighted average of different financial variables (interest rates, exchange rates, equity, etc.) at a weekly frequency.
EBP	Board of Governors	The Equity Bond Premium (EBP), based on Gilchrist and Zakrajšek (2012), is a measure of investor sentiment or risk appetite in the corporate bond market.

Appendix B Results for other financial-related topics

Table B.1: Taylor rule results — Supervision and Regulation

	FFR	FFR	FFR	FFR	SR	SR	SR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
r_{t-1}	0.876***	0.879***	0.881***	0.881***	0.923***	0.925***	0.925***
	(0.031)	(0.028)	(0.031)	(0.030)	(0.027)	(0.028)	(0.028)
$CPI_{t,h=4}$	0.219*	0.237**	0.210**	0.214**	0.166**	0.162**	0.166**
	(0.112)	(0.098)	(0.104)	(0.100)	(0.075)	(0.073)	(0.075)
$OG_{t,h=4}$	0.143***	0.159***	0.174***	0.173***	0.065***	0.060***	0.061***
	(0.046)	(0.044)	(0.043)	(0.043)	(0.021)	(0.022)	(0.023)
S&R Proportion		−0.028***		−0.006	−0.011		−0.006
		(0.009)		(0.010)	(0.011)		(0.021)
Neg. Tone			−0.798***	−0.707**		−0.179	−0.109
			(0.247)	(0.290)		(0.205)	(0.374)
AIC	-7.9	-12.56	-17.03	-15.19	39.36	39.33	41.19
SIC	4.37	2.16	-2.3	1.99	56.83	56.8	61.58
Observations	86	86	86	86	136	136	136
Adjusted R^2	0.985	0.986	0.987	0.987	0.990	0.990	0.990

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007, and January 1997 to December 2013, as indicated by the column names FFR and SR respectively. FFR denotes the target Federal Funds Rate, whereas SR in the column headline denotes the shadow rate of Wu and Xia (2016). The explanatory variables S&R topic proportion and Neg. Tone where computed based on speeches of all FOMC members for the topic Supervision and Regulation. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table B.2: Pre-crisis period — Tone Results for Supervision and Regulation

	Dependent Variable: Federal Funds Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
FFR_{t-1}	0.881***	0.875***	0.905***	0.874***
	(0.031)	(0.032)	(0.030)	(0.032)
$CPI_{t,h=4}$	0.210**	0.235**	0.177*	0.229**
	(0.104)	(0.112)	(0.102)	(0.113)
$OG_{t,h=4}$	0.174***	0.154***	0.136***	0.169***
	(0.043)	(0.047)	(0.050)	(0.041)
Neg. Tone	−0.798***	−0.213*	−0.157*	−0.647***
	(0.247)	(0.115)	(0.089)	(0.183)
AIC	-17.03	-4.23	-3.48	-19.1
SIC	-2.3	10.21	10.26	-4.37
Observations	86	82	73	86
Adjusted R^2	0.987	0.985	0.985	0.987

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the negative tone indicator with respect to the Supervision and Regulation topic was computed based on speeches of different subgroups of the FOMC, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table B.3: Taylor rule results — Financial Conditions

	FFR	FFR	FFR	FFR	SR	SR	SR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
r_{t-1}	0.876***	0.877***	0.885***	0.883***	0.936***	0.939***	0.939***
	(0.031)	(0.031)	(0.034)	(0.034)	(0.029)	(0.030)	(0.030)
$CPI_{t,h=4}$	0.219*	0.240**	0.219*	0.227**	0.174***	0.177***	0.177***
	(0.112)	(0.104)	(0.112)	(0.107)	(0.067)	(0.067)	(0.067)
$OG_{t,h=4}$	0.143***	0.142***	0.138***	0.139***	0.042*	0.034	0.034
	(0.046)	(0.044)	(0.046)	(0.046)	(0.023)	(0.026)	(0.026)
FC Proportion		−0.032***		−0.013	−0.029**		0.001
		(0.012)		(0.014)	(0.014)		(0.016)
Neg. Tone			−0.597***	−0.449**		−0.392**	−0.398
			(0.200)	(0.219)		(0.173)	(0.251)
AIC	-7.9	-11.56	-13.21	-11.68	32.7	29.45	31.45
SIC	4.37	3.17	1.51	5.5	50.18	46.93	51.84
Observations	86	86	86	86	136	136	136
Adjusted R^2	0.985	0.986	0.986	0.986	0.990	0.990	0.990

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007, and January 1997 to December 2013, as indicated by the column names FFR and SR respectively. FFR denotes the target Federal Funds Rate, whereas SR denotes the shadow rate of Wu and Xia (2016). The explanatory variables FC topic proportion and Neg. Tone where computed based on speeches of all FOMC members for the topic Financial Conditions. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table B.4: Pre-crisis period — Tone Results for Financial Conditions

	Dependent Variable: Federal Funds Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
FFR_{t-1}	0.885***	0.875***	0.917***	0.882***
	(0.034)	(0.033)	(0.029)	(0.033)
$CPI_{t,h=4}$	0.219*	0.228**	0.148	0.257**
	(0.112)	(0.116)	(0.095)	(0.119)
$OG_{t,h=4}$	0.138***	0.149***	0.105***	0.130***
	(0.046)	(0.046)	(0.038)	(0.046)
Neg. Tone	−0.597***	−0.135	−0.229*	−0.497***
	(0.200)	(0.127)	(0.125)	(0.159)
AIC	-13.21	-3.45	-17.23	-12.65
SIC	1.51	10.99	-3.57	2.08
Observations	86	82	72	86
Adjusted R^2	0.986	0.985	0.988	0.986

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the negative tone indicator with respect to the Financial Conditions topic was computed based on speeches of different subgroups of the FOMC, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table B.5: Taylor Rule Results — Housing

	FFR	FFR	FFR	FFR	SR	SR	SR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
r_{t-1}	0.876***	0.874***	0.873***	0.874***	0.926***	0.928***	0.926***
	(0.031)	(0.029)	(0.031)	(0.030)	(0.027)	(0.028)	(0.027)
$CPI_{t,h=4}$	0.219*	0.217**	0.221**	0.218**	0.151**	0.157**	0.163**
	(0.112)	(0.108)	(0.110)	(0.106)	(0.073)	(0.071)	(0.072)
$OG_{t,h=4}$	0.143***	0.149***	0.147***	0.149***	0.059***	0.055**	0.057**
	(0.046)	(0.045)	(0.047)	(0.046)	(0.022)	(0.025)	(0.023)
Housing Proportion		0.035*		0.034	−0.018		0.024
		(0.020)		(0.032)	(0.030)		(0.035)
Neg. Tone			0.392	0.025		−0.423	−0.706
			(0.418)	(0.624)		(0.517)	(0.804)
AIC	-7.9	-7.69	-6.75	-5.7	39.39	37.85	39.39
SIC	4.37	7.03	7.97	11.48	56.87	55.33	59.78
Observations	86	86	86	86	136	136	136
Adjusted R^2	0.985	0.985	0.985	0.985	0.990	0.990	0.990

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007, and January 1997 to December 2013, as indicated by the column names FFR and SR respectively. FFR denotes the target Federal Funds Rate, whereas SR denotes the shadow rate of Wu and Xia (2016). The explanatory variables Housing proportion and Neg. Tone where computed based on speeches of all FOMC members for the topic Housing. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table B.6: Pre-Crisis Period — By FOMC Members — Financial Stability and Housing

	Dependent Variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.873***	0.871***	0.893***	0.871***
	(0.027)	(0.030)	(0.029)	(0.028)
$CPI_{t,h=4}$	0.283***	0.272**	0.250**	0.252**
	(0.104)	(0.115)	(0.102)	(0.104)
$OG_{t,h=4}$	0.149***	0.147***	0.135***	0.147***
	(0.037)	(0.044)	(0.045)	(0.036)
FS Proportion	−0.054***	−0.018**	−0.018***	−0.039***
	(0.016)	(0.009)	(0.005)	(0.013)
Housing Proportion	0.056***	0.008	−0.007	0.056**
	(0.021)	(0.010)	(0.010)	(0.023)
AIC	-20.31	-4.65	-8.23	-19.95
SIC	-3.13	12.2	7.8	-2.76
Observations	86	82	73	86
Adjusted R^2	0.988	0.985	0.986	0.988

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the topic proportions were computed based on speeches of different subgroups of the FOMC, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Appendix C Robustness results

Table C.1: Taylor rule results — pre-crisis period — output gap and CPI nowcasts

	Dependent variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.882***	0.885***	0.926***	0.878***
	(0.057)	(0.060)	(0.050)	(0.056)
$CPI_{t,h=0}$	0.048**	0.047*	0.052**	0.041*
	(0.023)	(0.028)	(0.023)	(0.022)
$OG_{t,h=0}$	0.138**	0.127**	0.094	0.139**
	(0.058)	(0.064)	(0.058)	(0.057)
FS Proportion	−0.052***	−0.016	−0.014**	−0.042***
	(0.018)	(0.011)	(0.007)	(0.014)
AIC	2.03	14.09	7.15	2.22
SIC	16.76	28.53	20.9	16.94
Observations	86	82	73	86
Adjusted R^2	0.984	0.981	0.983	0.984

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007. The control variables are the output gap and CPI Greenbook *nowcasts*. The financial stability topic proportion indicator was computed based on speeches of different subgroups of the FOMC, as indicated in the column name. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table C.2: Pre-Crisis Period — By FOMC Members — Financial Stability and Economy

	Dependent Variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.877***	0.870***	0.882***	0.876***
	(0.030)	(0.030)	(0.032)	(0.031)
$CPI_{t,h=4}$	0.278***	0.275**	0.278***	0.260**
	(0.108)	(0.111)	(0.105)	(0.114)
$OG_{t,h=4}$	0.140***	0.147***	0.142***	0.134***
	(0.038)	(0.044)	(0.045)	(0.037)
Economy Proportion	0.001	0.006*	−0.005	−0.003
	(0.005)	(0.003)	(0.003)	(0.005)
FS Proportion	−0.046**	−0.010	−0.025***	−0.043**
	(0.021)	(0.010)	(0.008)	(0.019)
AIC	-15.35	-6.33	-9.9	-14.82
SIC	1.83	10.52	6.13	2.36
Observations	86	82	73	86
Adjusted R^2	0.987	0.985	0.987	0.987

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table C.3: Pre-Crisis Period — By FOMC Members — Financial Stability and MP

	Dependent Variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.877***	0.872***	0.890***	0.874***
	(0.030)	(0.031)	(0.029)	(0.031)
$CPI_{t,h=4}$	0.276**	0.262**	0.253**	0.255**
	(0.110)	(0.110)	(0.102)	(0.120)
$OG_{t,h=4}$	0.140***	0.147***	0.142***	0.141***
	(0.039)	(0.045)	(0.047)	(0.038)
MP Proportion	0.001	−0.003	0.003	0.007
	(0.008)	(0.005)	(0.004)	(0.005)
FS Proportion	−0.047**	−0.019*	−0.017***	−0.032**
	(0.018)	(0.010)	(0.005)	(0.015)
AIC	-15.34	-4.38	-8.09	-15.74
SIC	1.84	12.47	7.94	1.44
Observations	86	82	73	86
Adjusted R^2	0.987	0.985	0.986	0.987

Note: The table shows Taylor rule results for the period ranging from January 1997 to November 2007. MP denotes the Monetary Policy topic proportion. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table C.4: "LDA only" Taylor rule results — pre-crisis period

	Dependent variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.874***	0.871***	0.880***	0.878***
	(0.030)	(0.031)	(0.031)	(0.031)
$CPI_{t,h=4}$	0.287***	0.254**	0.226**	0.273**
	(0.107)	(0.112)	(0.104)	(0.117)
$OG_{t,h=4}$	0.145***	0.148***	0.157***	0.134***
	(0.042)	(0.046)	(0.049)	(0.041)
LDA FS Proportion	−0.032***	−0.006	−0.009**	−0.025**
	(0.011)	(0.007)	(0.004)	(0.010)
AIC	-14.11	-3.82	-6.4	-12.39
SIC	0.61	10.62	7.34	2.34
Observations	86	82	73	86
Adjusted R^2	0.987	0.985	0.986	0.986

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the financial stability topic proportion indicator was computed based on the topic-document distribution of the LDA. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

Table C.5: "LDA only" Taylor rule results — with stemming — pre-crisis period

	Dependent variable: Federal Funds Target Rate			
	FOMC	Governors	Fed Chair	Presidents
	(1)	(2)	(3)	(4)
r_{t-1}	0.874***	0.872***	0.887***	0.875***
	(0.032)	(0.031)	(0.030)	(0.032)
$CPI_{t,h=4}$	0.251**	0.242**	0.206*	0.261**
	(0.115)	(0.116)	(0.113)	(0.119)
$OG_{t,h=4}$	0.144***	0.146***	0.146***	0.141***
	(0.044)	(0.045)	(0.049)	(0.043)
LDA FS Proportion	−0.026**	−0.004	−0.009*	−0.022**
	(0.013)	(0.006)	(0.005)	(0.009)
AIC	-10.27	-3.36	-5.34	-10.36
SIC	4.46	11.08	8.41	4.36
Observations	86	82	73	86
Adjusted R^2	0.986	0.985	0.986	0.986

Note: The table shows pre-crisis Taylor rule results, ranging from January 1997 to November 2007, where the financial stability topic proportion indicator was computed based on the topic-document distribution of the LDA and using stemming in the pre-processing step of the corpus. The dependent variable is the target FFR. Standard errors are computed using a HAC based on Newey and West (1987). *p<0.1; **p<0.05; ***p<0.01.

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